Version 2.0

Advanced National Seismic System

Implementation Standards and Procedures

This document establishes the standards and procedures of the U.S. Geological Survey's (USGS) Earthquake Hazards Program (EHP) governing installation, configuration, and data exchange to facilitate a high-level of coordination, integration, and management of a robust and efficient monitoring system by participants in the Advanced National Seismic System (ANSS).

The Earthquake Hazards Reduction Act (P.L. 95–124 as amended) gives the USGS the Federal responsibility for providing notifications of earthquakes and its reauthorization in 2000 established the ANSS to modernize and expand the Nation's seismic monitoring infrastructure to provide accurate and timely data and information products for seismic events, including their effects on buildings and structures, employing modern monitoring methods and technologies.

These standards and procedures are intended to improve the quality of recorded data, track station specific information necessary for day-to-day operations and strategic planning, and coordinate the exchange of waveform and earthquake parameters to ensure system inter-operability.

All ANSS participants are required to follow these standards and procedures as well as all ANSS policies and the derivative standards, procedures, and specifications as they pertain to each participant's scope of operations and authority. EHP coordinates with ANSS participants on the development and updating of performance metrics against which all ANSS participants will be measured; the metrics are contained in the ANSS Performance Standards.

Permanent Seismograph Station Installation

Installation and operations of seismograph stations should follow the appropriate installation guidelines described in the following site construction and station installation guidelines, or any future guidelines endorsed by the ANSS National Implementation Committee (NIC):

- Free-field Sites (minimum standard):

(http://pubs.usgs.gov/of/2002/ofr-02-0144/ofr-02-0144.pdf**)**

Open File Report 02-92 "Methods of Installing United States National Seismograph Network (USNSN) Stations-A Construction Manual" provides technical guidelines on installation of broadband/strong motion free-field stations. A NIC workgroup should be formed to provide guidance on best practices for surface instrumentation and posthole construction.

- Reference Strong-motion Sites:

(https://www.strongmotion.org/archive/publications/guidelines/Guidelines_ANSS.pdf)

COSMOS document "Guidelines for Installation of Advanced National Seismic System Strong-Motion Reference Stations" provides technical guidelines on installations of reference strong motion stations. Data sampling rates for strong motion reference stations should be a minimum of 200 sps using triggered recording, and a minimum of 100 sps for continuous recording. In remote regions where bandwidth and/or power are an issue, 50 sps continuous data is acceptable.

- Structural Strong-motion Sites: (http://earthquake.usgs.gov/monitoring/anss/docs/ANSS_Guideline_civil.pdf)

Open File Report 2005-1039 "Guidelines for ANSS Seismic Monitoring of Engineered Civil Systems-Version 1.0" for general information about strong-motion installations in structures.

Temporary Seismograph Station Deployments

Any temporary seismic deployment supported by ANSS (either directly or indirectly) will adhere to the ANSS Data Products Policy. In addition, the EHP maintains portable seismograph systems at the ANSS Depot in Albuquerque and at offices in Menlo Park, Pasadena, and Seattle that are an ANSS resource for supplemental seismic monitoring following significant aftershock sequences, induced seismicity sequences, and unusual earthquake activity. To efficiently deploy and operate these specific portable systems ANSS participants must:

- Adhere to minimal deployment standards found in the EHP's "Guidelines for portable earthquake monitoring equipment and deployments."

Station Inventory and Metadata

Tracking of ANSS-supplied station equipment or ANSS-supported stations and reporting of associated descriptions of station attributes (metadata) are essential for day-to-day monitoring operations and as a tool for EHP management to assure quality.

ANSS participants are required to:

- Update Station metadata within 3 business days of the opening, closing, or other changes in station attributes (e.g., response, digitizer, sensor). Generate a dataless SEED volume for station metadata exchange. http://www.iris.edu/data/datalessDef.htm
- Migrate from dataless SEED volumes as a metadata exchange standard when StationXML is fully implemented. http://www.fdsn.org/xml/station

It is the intent of the ANSS with guidance from the NIC to require participating networks to:

- Use or populate Station Information System (https://anss-sis.scsn.org/sis) (SIS) for station inventory control and description and maintenance of station metadata.
- Make the metadata discoverable on the Internet for exchange with other seismic networks (this requirement will be fulfilled through use of SIS).

Distribution of Earthquake Products

Coordinated and integrated reporting of earthquake notification, characterization and impact requires common descriptions of, and standard methods for, distributing earthquake information. To ensure the authoritative and efficient distribution of earthquake information and impact products, ANSS participants must:

- Use Product Distribution Layer (PDL) as the distribution software for automatic and reviewed earthquake source parameters (e.g., origin time, location, magnitude, mechanism, uncertainties) and associated station parametric data (e.g., arrival time, amplitude, coda duration, quality), and for other event-centric products for which standards have been defined (ShakeMap, tectonic summaries, etc.). http://ehppdl1.cr.usgs.gov/index.html#documentation
- Updates to PDL must also be implemented in a timely manner. Critical bug fixes will be applied within one week, releases with small fixes or enhancements will be implemented within one month.

- Configuration of PDL must be consistent with the requirements to successfully transfer all ANSS products. Requirements will be determined by PDL developers and product producers.
- Use QuakeML as the standard for exchange of earthquake source and associated parameter data. https://quake.ethz.ch/quakeml
- Submit automatic and reviewed information in a timely fashion per the ANSS Performance Standards.

ShakeMap

ShakeMap operators are required to update software periodically, provide quality assurance of configurations and maps they generate, achieve remote backup, and work with ShakeMap leadership on ShakeMap-related data and product delivery. Performance expectations for regional seismic networks with regard to ShakeMap include:

- Distribute to NEIC all appropriate ShakeMap parameters and configurations to ensure redundant computation and delivery of ShakeMaps.

And for those networks running ShakeMap:

- Compute automatic and reviewed ShakeMaps within their designated region for all M3.5 or larger earthquakes.
- Report on ShakeMap operational statistics (trigger time, runtime, posting time, and version releases).
- Provide post-mortem reports on any operational issues, ShakeMap data quality, errors, or failures, or other issues upon request from the ANSS ShakeMap team or the ANSS coordinator.
- Provide the NEIC and other ANSS networks with appropriate ShakeMap parameters and configurations. NEIC and other networks will work with the authoritative regions to implement the region specific configurations.

The ANSS ShakeMap group will periodically release updated versions of the ShakeMap software. These software updates are necessary in order to maintain product quality and consistency among producers, compatibility with the USGS's website development, and the construction of new and updated products to end users, including the ShakeCast and PAGER systems. ANSS participant regional network ShakeMap operators will be required to:

- Follow update announcements via the shake-dev@geohazards.usgs.gov mailing list.
- Implement the upgrade within 6 months of an announced major release; 3 months for minor releases.
- Work with regions to develop consistent configuration of ShakeMap software based on recommendations of the ANSS ShakeMap team. The ShakeMap software should be configured to be consistent in terms of model selection, output data layers, and product download files.

ShakeAlert

Regional seismic networks which contribute data to ShakeAlert are required to provide low-latency continuous data streams, with their accompanying metadata, to the ShakeAlert production system. All data streams must initially be vetted via the ShakeAlert station acceptance standards and procedures. The ANSS ShakeAlert group will periodically release updates to the data delivery and acceptance standards.

Real-time Distribution and Archiving of Waveform Data

Real-time exchange of waveform data with neighboring networks and other supporting monitoring facilities improves the accuracy and reliability of seismic monitoring across the ANSS. Waveform exchange requires that seismic networks use common waveform protocols and software standards that ensure the timely and complete delivery of waveform data to and from supporting monitoring operations. ANSS participants are required to:

- Share all real time waveform data with other ANSS networks as requested.
- Use SeedLink (http://www.iris.edu/dms/nodes/dmc/services/seedlink) or Earthworm (https://seiscode.iris.washington.edu/projects/earthworm) for continuous real-time waveform data exchange with other ANSS networks.
- Archive continuous data and triggered high sample rate data (strong motion) of engineering interest at the IRIS Data Management Center, Northern California Earthquake Data Center, or the Southern California Earthquake Data Center.
- Provide access to waveservers to the National Strong-Motion Project (NSMP) for retrieval of strong-motion waveforms of significant earthquakes so that the data can be converted to COSMOS V0-3 formats and archived at the Center for Engineering Strong Motion Data; archive the waveform data at an established data center (see requirement above)
- Provide the NEIC and other ANSS networks with appropriate ShakeMap parameters (See **ShakeMap** section above).
  The NSMP provides station metadata in dataless SEED and access to waveservers containing available event waveform data recorded by NSMP stations. Participating networks are required to configure their systems to automatically request and include NSMP data, as needed, into published products.

Monitoring Systems Operation, Configuration and Management

The majority of ANSS-supported RSNs operate the processing system ANSS Quake Management System (AQMS) that significantly improves development, operational efficiencies and interoperability. While this system generally performs well in its intended mission, each RSN has differences in source-receiver geometry, geology, and other network attributes that require software modifications to achieve the RSN monitoring goal of producing and distributing accurate locations and magnitudes and generating ANSS products (e.g. ShakeMap).

To encourage efficient operations and developments that improve the overall capabilities of the RSN and ANSS as a system, each RSN operating AQMS must:

- Ensure that software modifications designed to improve operational capabilities are well-tested and vetted by AQMS developers.
- Contribute newly developed or modified code to the AQMS source code repository.

All ANSS-supported RSNs are required to:

- Provide prior notification and justification to ANSS of major changes in network configuration (e.g., changing network-station-component-location or sample rates) that could impact other users.
- Provide prior notification, documentation including testing results, and justification to ANSS of major changes in location or magnitude procedures or other products that might be seen as a “deviation” from previously derived products.
- Provide NEIC and neighboring RSNs prior notification of major changes in hardware, software and/or communications that might result in a short-term disruption of services.

ANSS recognizes that maintaining and operating monitoring systems hardware and software is a significant and necessary operational cost. Consequently, ANSS allows for these systems to be leveraged with local and state contributions to seismic monitoring, that result in the system being improved as a whole.

IT Security

ANSS-supported networks must establish adequate IT security to protect their assets from unauthorized intrusions to minimize the possibility of hacking and associated corruption of services and to ensure continuity of operation as a system. ANSS seismic networks must adhere to computer network security standards outlined in the Internet Security Agreement (ISA) signed by ANSS participants. The ISA covers all computer systems that acquire, process or distribute seismic waveform data as part of ANSS and all internet accessible appliances such as radios, cell-modems, VSATs and seismic stations. A new ISA will be provided for signature in the first month of each cooperative agreement.

Continuity of Operations Plan

Each ANSS participant under a Cooperative Agreement with the USGS should establish a plan to follow that will ensure continuity of operations or coverage of authoritative area in unusual circumstances. Specifically, Tier 1 networks under a Cooperative Agreement are required to:

- Establish a Continuity of Operations Plan (COOP) plan within 6 months of beginning the Cooperative Agreement and maintain, review, and update this plan on a regular basis. COOPs must include notification procedures to supporting seismic networks of any significant network disruption (i.e., fire, natural disaster, long-term power disruption, preventive maintenance of waveform and source parameter distribution subsystems). An example of a COOP can be obtained from the ANSS program coordinator.

Post-earthquake Reporting

ANSS response to earthquakes that draw public concern or media attention in the U.S. or its territories are important tests of ANSS abilities to meet expectations in terms of timeliness, accuracy, and completeness of earthquake information. For large earthquakes and their associated aftershocks, coordination between ANSS-supported networks is essential to ensure data collection of near-source high-frequency ground motions and timely distribution of accurate locations and magnitudes.

For large domestic earthquakes within an ANSS RSN's authoritative region, that RSN must:

- Adhere to the **Large Magnitude Policy** (see Attachment J).
- Provide ANSS management upon request a network status report that includes details on loss of infrastructure (e.g., downed communications, inoperable stations) and/or capabilities (e.g., cannot disseminate earthquake information) that impact operations of ANSS as a system.
- Coordinate with NEIC and partnering networks on relative roles and responsibilities regarding the dissemination of aftershock locations, magnitudes and other essential products (e.g., ShakeMap, moment tensor solutions).
- Provide ANSS anticipated needs for aftershock monitoring equipment, including a request for USGS staff support.

To collect information on ANSS performance in response to an earthquake of public concern, and to improve this response in future episodes, ANSS networks must be able to report upon request from ANSS management a post-mortem for significant events that includes:

- Detailed summary timeline and distribution of all network generated products (e.g., location, magnitude, moment tensor solution, and ShakeMaps),
- Coordination timeline with participating ANSS networks,
- Highlights of technical and operational problems encountered, and
- A report on corrective actions completed or planned.
- For planned actions, provide an estimate of tasks and completion dates.

Website

Tier I network websites should at minimum list:

- Computed hypocenters and magnitudes
- The network's monitoring objectives in the context of the ANSS
- The scope of coordination with other monitoring networks
- Maps and lists of stations used in routine monitoring
- Links to earthquake products and network services
- Acknowledgement of participation in ANSS and support from USGS with links to EHP and ANSS webpages
- Partnering networks and archives that receive waveform data and earthquake information products.

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